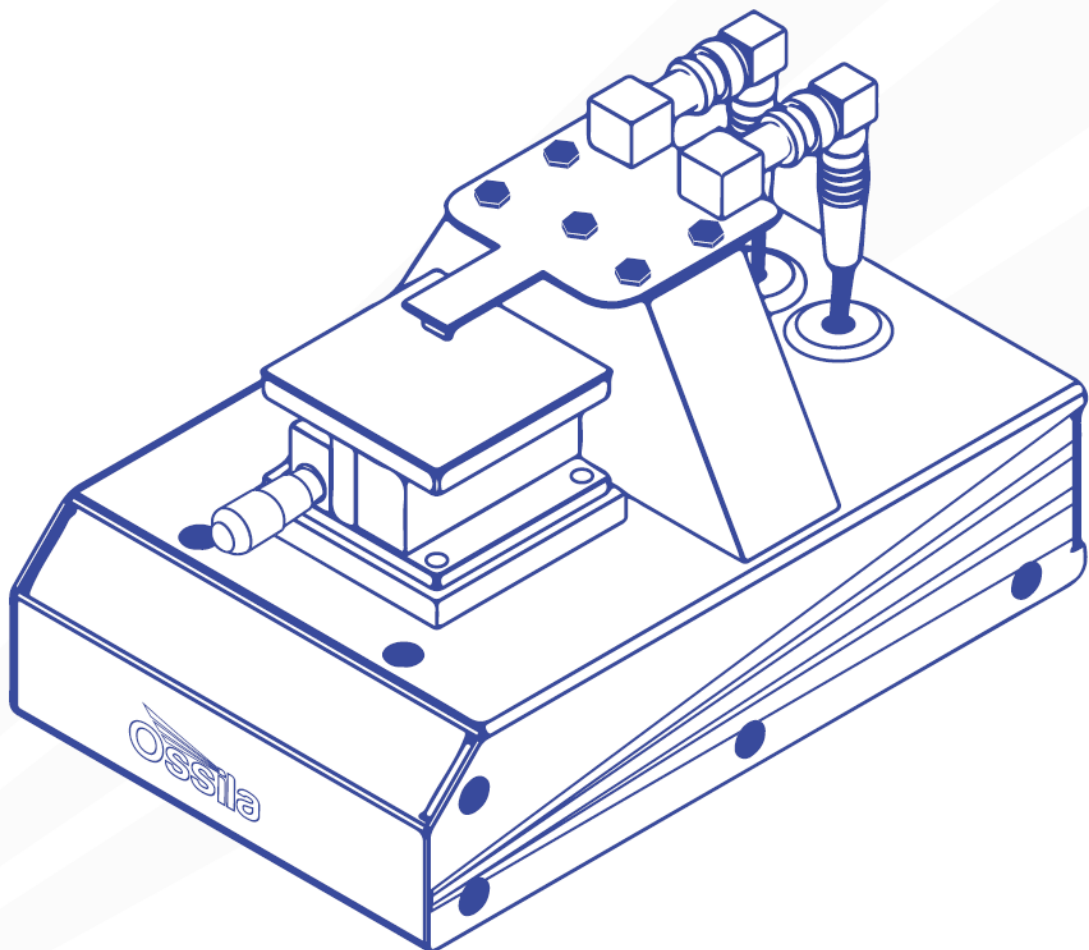


FOUR-POINT PROBE USER MANUAL

Manual version: 3.1.K
Product code: T2001A
Product Version: 3.0
Software version: 1.0



Contents

1. Overview	3
2. EU Declaration of Conformity (DoC).....	4
3. Safety.....	7
3.1 Warning	7
3.2 Use of Equipment.....	7
3.3 Hazard Icons	7
3.4 General Hazards	7
3.5 Power Cord Safety	8
3.6 Servicing	8
3.7 Health and Safety – Servicing.....	8
4. Requirements.....	9
5. Unpacking.....	10
5.1 Packing List.....	10
5.2 Damage Inspection.....	10
6. Specifications.....	11
7. System Components.....	12
8. Installation.....	12
9. Operation.....	13
9.1 Taking a Measurement	13
9.2 Software Settings.....	13
9.2.1 Basic Settings	14
9.2.2 Saving Results	15
9.2.3 Advanced Settings	15
10. Test Head	18
10.1 Taking a Measurement	18
11. Troubleshooting.....	20
11.1 Installation and Setup	20
11.2 Error Messages and Warnings	21
12. Related Products	22
12.1 Related Consumables	22
12.2 Related Equipment.....	22

1. Overview

The Ossila Four-Point Probe System is part of the Institute of Physics award-winning Solar Cell Prototyping Platform*. It is a low-cost solution for rapid and reliable measurement of the sheet resistance, resistivity, and conductivity of materials.

The system includes a four-point probe, source measure unit, and easy-to-use PC software — enabling more laboratories to measure sheet resistance for an affordable price. The probe head uses gentle spring-loaded contacts instead of sharp needles, minimising damage to delicate samples (e.g., polymer films that are only a few nanometres thick).

It is operated via the specifically designed PC software, which automatically calculates appropriate geometrical correction factors for the sample to give accurate values for the sheet resistance. If the sample thickness is provided, the software will further calculate resistivity and conductivity.

*The Ossila Solar Cell Prototyping Platform is a complementary collection of substrates, materials, and equipment as part of a high-performance standard photovoltaic reference architecture. This platform enables researchers to produce high-quality, fully functional solar cells which can be used as a reliable baseline.

For more information: www.ossila.com/pages/solar-cell-prototyping-platform.



2. EU Declaration of Conformity (DoC)

We

Company Name: Ossila BV

Postal Address: Biopartner 3 building, Galileiweg 8

Postcode: 2333 BD Leiden

Country: The Netherlands

Telephone number: +31 (0)718 081020

Email Address: info@ossila.com

declare that the DoC is issued under our sole responsibility and belongs to the following product:

Product: Four Point Probe System (T2001A3)

Serial number: T2001A3- xxxx

Object of declaration:

Four Point Probe System (T2001A3)

The object of declaration described above is in conformity with the relevant Union harmonisation legislation:

EMC Directive 2014/30/EU

RoHS Directive 2011/65/EU

Signed:



Name: Dr James Kingsley

Place: Leiden

Date: 16/11/2021

Декларация за съответствие на ЕС

Производител: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Декларира с цялата си отговорност, че посоченото оборудване съответства на приложимото законодателство на ЕС за хармонизиране, посочено на предходната(-ите) страница(-и) на настоящия документ.

[Čeština] Prohlášení o shodě EU

Výrobce: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Prohlašujeme na vlastní odpovědnost, že uvedeně zařízení je v souladu s příslušnými harmonizačními předpisy EU uvedenými na předchozích stranách tohoto dokumentu.

[Dansk] EU-overensstemme Iserklæring

Producent: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Erklærer herved, at vi alene er ansvarlige for, at det nævnte udstyr er i overensstemmelse med den relevante EU-harmoniseringslovgivning, der er anført på den/de foregående side(r) i dette dokument.

[Deutsch] EU-Konformitätserklärung

Hersteller: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Wir erklären in alleiniger Verantwortung, dass das aufgeführte Gerät konform mit der relevanten EU-Harmonisierungsgesetzgebung auf den vorangegangenen Seiten dieses Dokuments ist.

[Eesti keel] ELi vastavusavaldus

Tootja: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Kinnitame oma ainuvastutust, et loetletud seadmed on kooskõlas antud dokumendi eelmisel leheküljel / eelmistel lehekülgedel ära toodud asjaomaste ELi ühtlustamise õigusaktidega.

[Ελληνικά] Δήλωση πιστότητας ΕΕ

Κατασκευαστής: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Δηλώνουμε υπεύθυνα ότι ο αναφερόμενος εξοπλισμός συμμορφώνεται με τη σχετική νομοθεσία εναρμόνισης της ΕΕ που υπάρχει στις προηγούμενες σελίδες του παρόντος εγγράφου.

[Español] Declaración de conformidad UE

Fabricante: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Declaramos bajo nuestra única responsabilidad que el siguiente producto se ajusta a la pertinente legislación de armonización de la UE enumerada en las páginas anteriores de este documento.

[Français] Déclaration de conformité UE

Fabricant: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Déclarons sous notre seule responsabilité que le matériel mentionné est conforme à la législation en vigueur de l'UE présentée sur la/les page(s) précédente(s) de ce document.

[Hrvatski] E.U izjava o sukladnosti

Proizvođač: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Izjavljujemo na vlastitu odgovornost da je navedena oprema sukladna s mjerodavnim zakonodavstvom EU-a o usklađivanju koje je navedeno na prethodnoj(nim) stranici(ama) ovoga dokumenta.

[Italiano] Dichiarazione di conformità UE

Produttore: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Si dichiara sotto la propria personale responsabilità che l'apparecchiatura in elenco è conforme alla normativa di armonizzazione UE rilevante indicata nelle pagine precedenti del presente documento.

[Latviešu] ES atbilstības deklarācija

Ražotājs: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Ar pilnu atbildību paziņojam, ka uzskaitītais aprīkojums atbilst attiecīgajiem ES saskaņošanas tiesību aktiem, kas minēti iepriekšējās šī dokumenta lapās.

[Lietuvių k.] ES atitikties deklaracija

Gamintojas: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

atsakingai pareiškia, kad išvardinta įranga atitinka aktualius ES harmonizavimo teisės aktus, nurodytus ankstesniuose šio dokumento

[Magyar] EU-s megfelelőségi nyilatkozat

Gyártó: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Kizárólagos felelősségünk mellett kijelentjük, hogy a felsorolt eszköz megfelel az ezen dokumentum előző oldalán/oldalain található EU-s összehangolt jogszabályok vonatkozó rendelkezéseinek.

[Nederlands] EU-Conformiteitsverklaring

Fabrikant: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Verklaart onder onze uitsluitende verantwoordelijkheid dat de vermelde apparatuur in overeenstemming is met de relevante harmonisatiewetgeving van de EU op de vorige pagina('s) van dit document.

[Norsk] EU-samsvarserklæring

Produsent: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Erklærer under vårt eneansvar at utstyret oppført er i overholdelse med relevant EU-harmoniseringslovverk som står på de(n) forrige siden(e) i dette dokumentet.

[Polski] Deklaracja zgodności Unii Europejskiej

Producent: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Oświadczamy na własną odpowiedzialność, że podane urządzenie jest zgodne ze stosownymi przepisami harmonizacyjnymi Unii Europejskiej, które przedstawiono na poprzednich stronach niniejszego dokumentu.

[Por tuguês] Declaração de Conformidade UE

Fabricante: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Declara sob sua exclusiva responsabilidade que o equipamento indicado está em conformidade com a legislação de harmonização relevante da UE mencionada na(s) página(s) anterior(es) deste documento.

[Română] Declarație de conformitate UE

Producător: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Declară pe proprie răspundere că echipamentul prezentat este în conformitate cu prevederile legislației UE de armonizare aplicabile prezentate la pagina/paginile anterioare a/ale acestui document.

[Slovensky] Vyhlásenie o zhode pre EÚ

Výrobca: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Na vlastnú zodpovednosť prehlasuje, že uvedené zariadenie je v súlade s príslušnými právnymi predpismi EÚ o harmonizácii uvedenými na predchádzajúcich stranách tohto dokumentu.

[Slovenščina] Izjava EU o skladnosti

Proizvajalec: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

s polno odgovornostjo izjavlja, da je navedena oprema skladna z veljavno uskladitveno zakonodajo EU, navedeno na prejšnji strani/prejšnjih straneh tega dokumenta.

[Suomi] EU-vaatimusten mukaisuusvakuutus

Valmistaja: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Vakuutamme täten olevamme yksin vastuussa siitä, että tässä asiakirjassa luetellut laitteet ovat tämän asiakirjan sivuilla edellisillä sivuilla kuvattujen olennaisten yhdenmukaistamista koskevien EU-säädösten vaatimusten mukaisia.

[Svenska] EU-försäkran om överensstämmelse

Tillverkare: Ossila BV, Biopartner 3 building, Galileiweg 8, 2333 BD Leiden, NL.

Vi intygar härmed att den utrustning som förtecknas överensstämmer med relevanta förordningar gällande EU-harmonisering som finns på föregående sidor i detta dokument.

3. Safety

3.1 Warning

- The absolute maximum input voltage for the Vsense channels is ± 12 V. Do NOT apply input while not powered.

3.2 Use of Equipment

The Ossila Four-Point Probe System is designed to be used as instructed. It is intended for use under the following conditions:

- Indoors in a laboratory environment (Pollution Degree 2).
- Altitudes up to 2000m.
- Temperatures of 5°C to 40°C; maximum relative humidity of 80% up to 31°C.

The unit is supplied with a 24 VDC power adapter with a power cord for the country of purchase, in accordance with European Commission regulations and British Standards. Use of any other electrical power cables, adaptors, or transformers is not recommended.

3.3 Hazard Icons

The following symbols can be found at points throughout the rest of the manual. Note and read each warning before attempting any associated operations associated with it:

Table 3.1. Hazard warning labels used in this manual.

Symbol	Associated Hazard
	Electrical shock

3.4 General Hazards

Before installing or operating the Ossila Four-Point Probe System there are several health and safety precautions which must be followed and executed to ensure safe installation and operation.

3.5 Power Cord Safety



Emergency power disconnect options: use the power cord as a disconnecting method and remove from wall. To facilitate disconnect, make sure the power outlet for this cord is readily accessible to the operator.

3.6 Servicing

If servicing is required, please return the unit to Ossila Ltd. The warranty will be invalidated if:

- Modification or service has been carried out by anyone other than an Ossila engineer.
- The Unit has been subjected to chemical damage through improper use.
- The Unit has been operated outside the usage parameters stated in the user documentation associated with the Unit.
- The Unit has been rendered inoperable through accident, misuse, contamination, improper maintenance, modification, or other external causes.

3.7 Health and Safety – Servicing



Servicing should only be performed by an Ossila engineer. Any modification or alteration may damage the equipment, cause injury, or death. It will also void your equipment's warranty.

4. Requirements

Table 4.1 details the power requirements for the system, and the minimum computer specifications for the Ossila Sheet Resistance software.

Table 4.1. Four-Point Probe System requirements.

Power	24 VDC
Operating Systems	Windows 10 or 11 (32-bit or 64-bit)
CPU	Dual Core 2 GHz
RAM	2 GB
Available Hard Drive Space	194 MB
Monitor Resolution	1440 x 900
Connectivity	USB 2.0 Ethernet (requires DHCP)

5. Unpacking

5.1 Packing List

The standard items included with the Ossila Four-Point Probe System are:

- The Ossila Four-Point Probe.
- 24 VDC power adapter.
- USB-B cable.
- USB memory stick pre-loaded with the user manual, software installer, QC data, and USB drivers.
- 400 – 450 nm FTO coated glass substrate (60 x 60 x 2.2 mm).
- 10 k Ω resistor test head.

5.2 Damage Inspection

Examine the components for evidence of shipping damage. If damage has occurred, please contact Ossila directly for further action. The shipping packaging will come with a shock indicator to show if there has been any mishandling of the package during transportation.

6. Specifications

The Four-Point Probe System measurement specifications are shown in **Table 6.1** and **Table 6.2**, and the physical specifications are shown in **Table 6.3**.

Table 6.1. Four-Point Probe System measurement specifications.

Voltage range	$\pm 100\ \mu\text{V}$ to $\pm 10\ \text{V}$
Current range	$\pm 1\ \mu\text{A}$ to $\pm 200\ \text{mA}$ (5 ranges)
Sheet resistance range	100 m Ω /square to 10 M Ω /square

Table 6.2. Accuracy and precision of the Four-Point Probe System at each resistance range. Accuracy is the maximum deviation from the true value. Precision is the maximum deviation between identical measurements (useful for comparative measurements).

Sheet Resistance	Accuracy	Precision	Measured at Range
100 m Ω /square	$\pm 8\%$	$\pm 3\%$	200 mA
1 Ω /square	$\pm 2\%$	$\pm 0.5\%$	200 mA
10 Ω /square	$\pm 1\%$	$\pm 0.5\%$	200 mA
100 Ω /square	$\pm 1\%$	$\pm 0.05\%$	20 mA
1 k Ω /square	$\pm 1\%$	$\pm 0.03\%$	20 mA
10 k Ω /square	$\pm 1\%$	$\pm 0.02\%$	2 mA
100 k Ω /square	$\pm 2\%$	$\pm 0.05\%$	200 μA
1 M Ω /square	$\pm 8\%$	$\pm 0.5\%$	20 μA
10 M Ω /square	$\pm 30\%$	$\pm 5\%$	20 μA

Table 6.3. Four-Point Probe System physical specifications.

Probe Spacing	1.27 mm
Rectangular Sample Size Range	Long Edge Minimum: 4 mm Short Edge Maximum: 60 mm
Circular Sample Size Range (Diameter)	4 mm to 76.2 mm
Maximum Sample Thickness	10 mm
Overall Dimensions	Width: 145 mm Height: 150 mm Depth: 240 mm

7. System Components

The Four-Point Probe System is comprised of: the Ossila Four-Point Probe System (**Figure 7.1**) and the Ossila Sheet Resistance Software (**Figure 7.2**).



Figure 7.1. The Ossila Four-Point Probe.

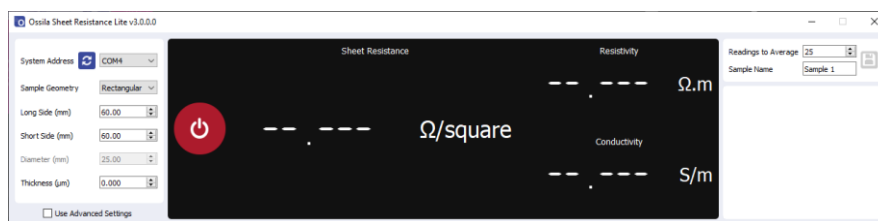


Figure 7.2. The Ossila Sheet Resistance Lite software.

8. Installation

1. Install the Ossila Sheet Resistance Lite software on your PC.
 - I. Run the file 'Ossila-Sheet-Resistance-Lite-Installer-vX-X-X-X.exe' on the USB memory stick provided.
 - II. Follow the on-screen instructions to install the software.
2. Connect the 24 VDC power adaptor to the power socket on the rear of the unit.
3. Connect the unit to your PC using the provided USB-B cable, or an Ethernet cable if preferred.
 - I. If you are using a USB connection and the unit is not detected, please refer to the SMU USB Driver Installation Guide found on the USB memory stick.

Note: The Ossila Sheet Resistance Lite software and Source Measure Unit USB drivers can also be downloaded from www.ossila.com/pages/software-drivers

9. Operation

9.1 Taking a Measurement

1. Place your sample in the centre of the vertical stage.
2. Raise the platform until the probes have retracted approximately half-way into their housing.
 - I. One full turn of the micrometer (after initial contact is made) is a good way to ensure that there is good electrical contact between the probes and your sample.
 - II. Ensure that the probes make contact with the centre of the sample.
 - III. For rectangular samples, the longest edge should be aligned parallel to the probes.
3. Start the Ossila Sheet Resistance Lite software. The window shown in **Figure 9.1** will open.
4. Set the appropriate settings in the software (explained in more detail in **Section 9.2**).
5. Click the on/off toggle button.
 - I. The system will attempt to pass a current between through the sample.
 - II. If a current can be passed though the sample, the system will measure the **sheet resistance**, which will be displayed in the program.
 - III. If a thickness has been provided, the **resistivity** and **conductivity** will also be displayed.
 - IV. The measurement will continue until the on/off toggle button is clicked or the software is closed.

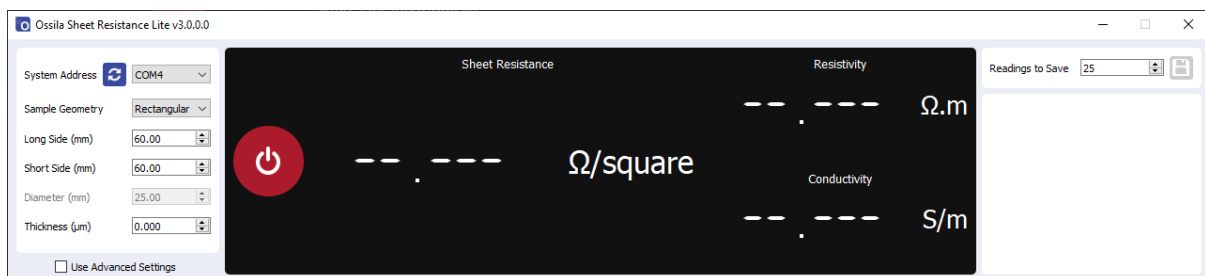
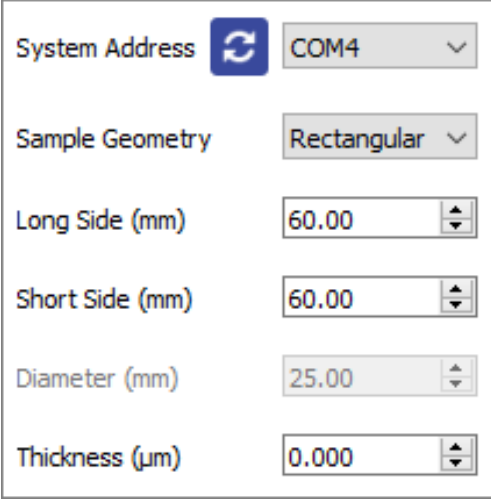


Figure 9.1. Ossila Sheet Resistance Lite software.

9.2 Software Settings

There are several settings in the program which must be filled in before taking a measurement. These are found in the column on the left of the window, as shown in **Figure 9.1**.

9.2.1 Basic Settings



System Address		COM4
Sample Geometry		Rectangular
Long Side (mm)		60.00
Short Side (mm)		60.00
Diameter (mm)		25.00
Thickness (μm)		0.000

Figure 9.2. Basic settings.

(I) System Address

- Select the COM port or IP address of the connected unit you intend to use (USB and Ethernet connection respectively).
 - I. This box will be populated automatically with the addresses of any units connected to the computer or network.

(II) Geometry

- Select the geometry of the sample being measured.
 - I. This is required to calculate the geometrical correction factor for the current sample.
 - II. If the shape of the sample is irregular, consider whether it is closer to rectangular or circular and then estimate what size of that shape could fit within the sample.

(III) Long Side (Rectangular Sample)

- Sets the length of the long side of the sample in mm (if the sample is rectangular).
 - I. This is required for calculating the appropriate geometrical correction factor.

(IV) Short Side (Rectangular Sample)

- Sets the length of the short side of the sample in mm (if the sample is rectangular).
 - I. This is required for calculating the appropriate geometrical correction factor.

(V) Diameter (Circular Sample)

- Sets the diameter of the sample in mm (if the sample is circular).
 - I. This is required for calculating the appropriate geometrical correction factor.

(VI) Thickness (Optional)

- Sets the thickness of the conductive layer being measured in μm .
 - I. This enables the calculation of the resistivity and conductivity of the sample, as well as calculating a thickness correction factor for samples with a thickness greater than 40% of the probe spacing.
 - II. It is not needed for sheet resistance measurements of samples with a thickness less than 40% of the probe spacing, thus can be set to 0 if not known.

9.2.2 Saving Results



Figure 9.3. Save settings.

(I) Readings to Save

- Set the number of measurements to save.

(II) Save

- Opens a file dialog window to choose where to save the data.

(III) Saved Data Format

- The applied current, measured voltage, and measured sheet resistance are saved to the file.
- The mean and standard deviation of the sheet resistance measurements are saved to the same file, placed after the data readings.
- If a thickness is provided, the resistivity and conductivity values are also saved.

9.2.3 Advanced Settings

Advanced settings can be found by checking the “Use Advanced Settings” box below the basic settings. This will also show the voltage and current set between the outer probes, and voltage measurements between the inner probes. Note that these settings will only be used whilst “Use Advanced Settings” box is ticked, default settings will be used when not ticked.

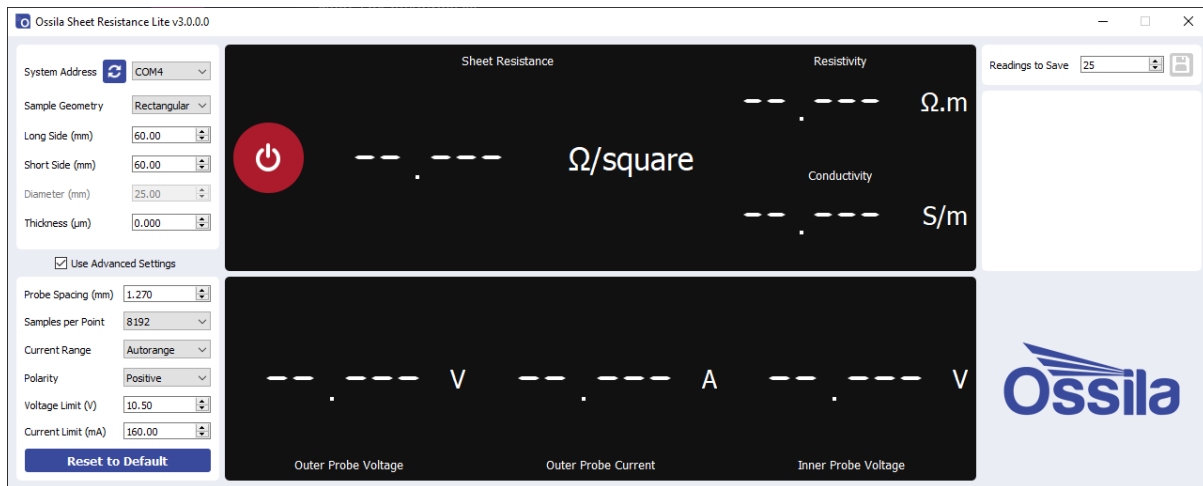


Figure 9.4. Ossila Sheet Resistance software showing advanced settings options.

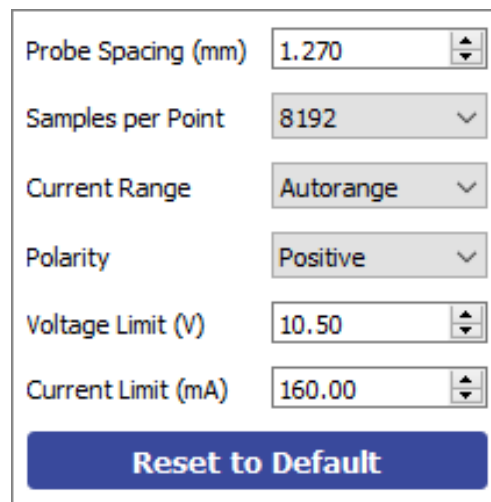


Figure 9.5. Advanced settings.

(I) Probe Spacing

- Sets the spacing between each of the probes in mm.
 - I. This is required to determine the appropriate geometric correction factors for the sample being measured.

(II) Samples per Point

- Select the number of samples to be taken for each measurement.
 - I. A higher number of samples per point will improve the accuracy and precision of the measurement. However, this will increase the time taken for it to be performed.

(III) Current Range

- Select whether the appropriate range should be automatically determined or whether a specific range of currents is used.
 - I. This defines the upper limit and accuracy of current measurements that can be performed by the unit.
 - II. Autorange will enable the measurement to automatically switch ranges as needed.
 - III. The maximum current values for each range are shown in the range selection box.

(IV) Polarity

- Sets whether the measurement polarity is positive or negative.

(V) Voltage Limit

- Sets the maximum voltage the measurement can apply to the sample in volts.
 - I. If the voltage limit is exceeded the measurement will stop.

(VI) Current Limit

- Sets the maximum current the measurement can apply to the sample in mA.
 - I. If the current limit is exceeded the measurement will stop.

(VII) Reset to Default

- Clicking this button will reset all advanced settings to their default values.

10. Test Head

The system is shipped with a test head that can be used to verify the correct operation the system by providing a reference measurement. It is designed to give a response of 10 k Ω when a sheet resistance measurement is performed on it using the system.

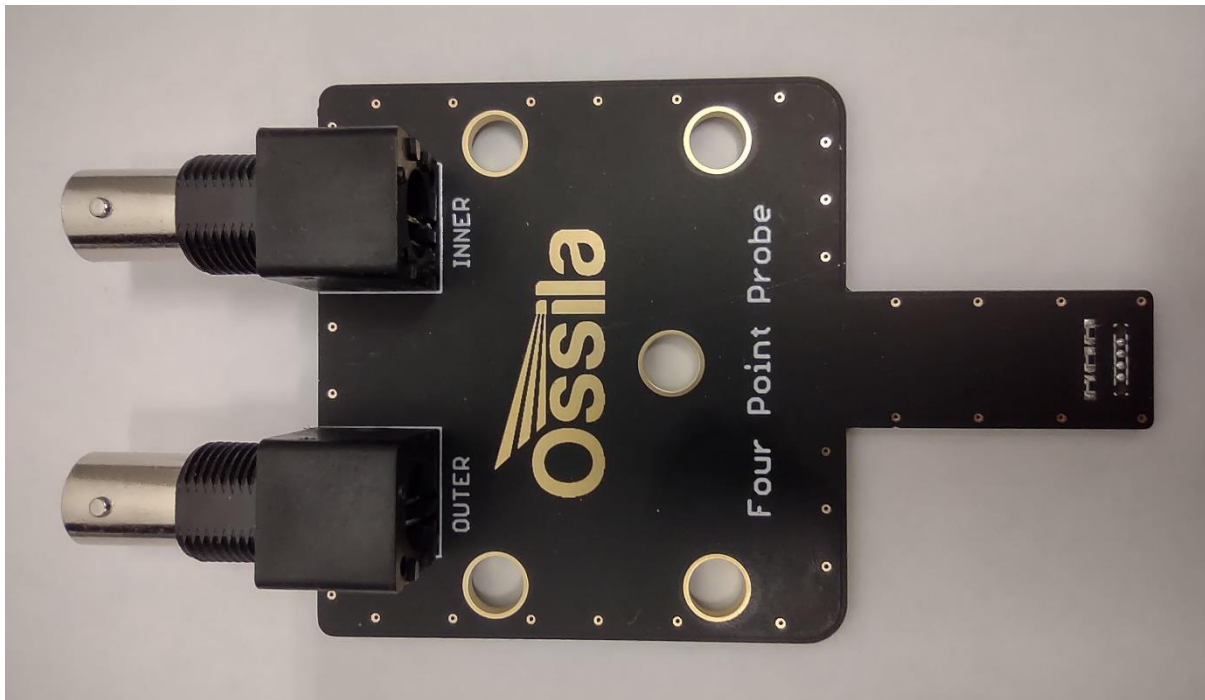
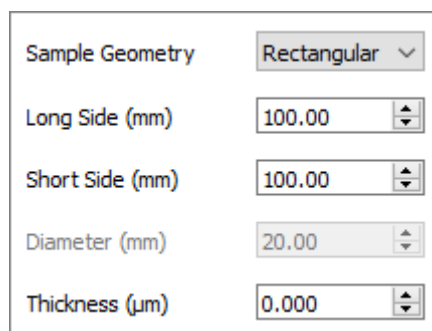


Figure 10.1. Four-point probe test head.

10.1 Taking a Measurement

1. Replace the four-point probe head on the system with the test head.
 - I. To do this first disconnect the cables, then remove the 5 screws attaching the head to the system.
 - II. Remove the four-point probe head and place the test head on the system.
 - III. Attach the test head using the screws, then connect the cables.
2. Plug in and switch on the system.
3. Allow at least 30 minutes for the system to warm up.
4. Start the Sheet Resistance Lite software and enter the settings in **Figure 10.2**.
 - I. Note, Long Side and Short Side can be any value greater than 55 mm, this is to ensure that no correction factor is applied to the measurement.



A dialog box titled 'Measurement settings for the test head' with five input fields, each with a numeric keypad icon to its right:

- Sample Geometry: Rectangular (dropdown menu)
- Long Side (mm): 100.00
- Short Side (mm): 100.00
- Diameter (mm): 20.00
- Thickness (μm): 0.000

Figure 10.2. Measurement settings for the test head.

5. Start the measurement.
6. The system should measure a sheet resistance between 9.9 and 10.1 $\text{k}\Omega/\text{square}$ (within 1% of 10 $\text{k}\Omega/\text{square}$).

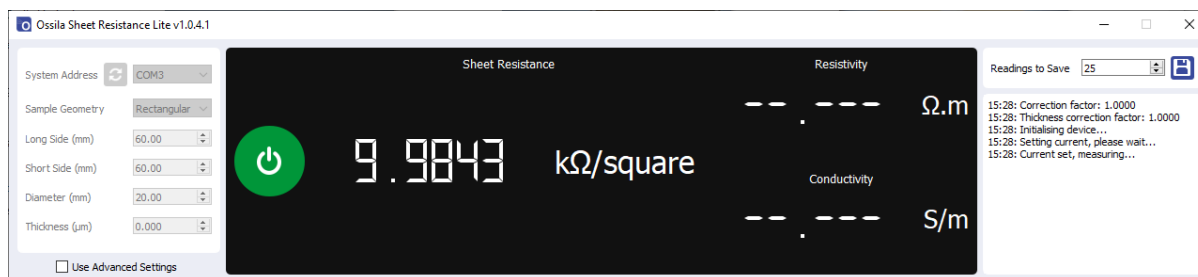


Figure 10.3. Example measurement of the test head.

11. Troubleshooting

Most of the issues that may arise will be detailed here. However, if you encounter any issues that are not detailed here, then contact us by email at info@ossila.com. We will respond as soon as possible.

11.1 Installation and Setup

Problem	Possible Cause	Action
No power/display	The power supply may not be connected properly.	Ensure the system is firmly plugged into the power supply, and that the plug is connected to both the adaptor and a working power socket.
	The power supply adaptor has a fault.	Contact Ossila for a replacement power supply adaptor.
Software does not start	The wrong version of Windows is installed on the computer.	Install the software on a computer with Windows 10 or newer.
	The software has not installed properly.	Try reinstalling the software.
Cannot connect to the system via USB	The USB cable may not be connected properly.	Ensure the USB cable is firmly plugged in at both ends.
	The USB cable may not be connected to a working USB port.	Try connecting the unit to a different USB port on the computer.
	The USB cable is defective.	Try using a different USB-B cable, and contact Ossila if necessary.
Cannot connect to the system via network	The MAC address of the unit is not registered with the internal network.	Register the system on the network using the MAC address obtained via a USB connection (see Source Measure Unit manual).
	The Ethernet cable may not be connected properly.	Ensure the Ethernet cable is firmly plugged in at both ends.
	The Ethernet cable is defective.	Try using a different Ethernet cable.

11.2 Error Messages and Warnings

Message	Description
Current limit exceeded	The measured current is greater than the set current limit.
Voltage limit exceeded	The output voltage is greater than the set voltage limit.
Unable to measure sample, resistance outside of measurable range	The system is unable to pass a current through the sample under test.
Long edge must be able to fit all probes	The long edge of a rectangular sample is shorter than 3 times the probes spacing.
Diameter must be able to fit all probes	The diameter of a circular samples is shorter than 3 times the probes spacing.
Short edge cannot be longer than the long edge	The short edge is greater than the long edge for a rectangular sample.
Sample removed, stopping measurement	The system has detected that the sample has been removed.
Error communicating with system	The software is unable to connect to the system.
Unable to open file: permission was denied	The software does not have the necessary permissions to access the given file path, or the file is already open in other software.
Unable to save file: permission was denied	The software does not have the necessary permissions to access the given file path, or the file is already open in other software.

12. Related Products

12.1 Related Consumables



ITO Coated Substrates

Our range of ITO substrates for OPV, OLED, and sensing applications.

Product codes: S111 / S101 / S211 / S281 / S171



Flat Tip Tweezers

Provides a good substrate grip without scratching.

Product code: C121



FTO Coated Substrates

Designed to be used as transparent electrodes for thin-film photovoltaics.

Product codes: S301 / S302 / S303 / S304



Substrate Cleaning Rack

Holds 20 substrates for a variety of processing techniques.

Product code: E101

12.2 Related Equipment



Spin Coater

Product high-quality coatings without any substrate warping. Perfect for busy labs with limited space.

Product code: L2001A3



Syringe Pump

High-precision, programmable single and dual syringe pumps for automatic dispensing of solutions.

Product codes: L2003S1 / L2003D1



UV Ozone Cleaner

For removing contamination on the surface of samples, providing you with ultraclean surfaces within minutes.

Product code: L2002A2



Source Measure Unit

Source voltage, measure current, get data. Simplify and accelerate your data collection!

Product code: P2005A2